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INFORMATION CIRCULAR

SOME PRELIMINARY DATA ON METHODS FOR CONTROLLING THE DUST HAZARDS IN MECHANICAL MINING

BY

C. W. OWINGS

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UNITED STATES DEPARTMENT OF THE INTERIOR - BUREAU OF MINES

SOME PRELIMINARY DATA ON METHODS FOR CONTROLLING THE DUST HAZARDS IN MECHANICAL MINING[1]

By C. W. Owings[2]

INTRODUCTION

Control of dust in mechanical mining in bituminous-coal mines of the United States is one of the outstanding problems of the mining industry today, yet relatively few mines have adopted adequate precautionary measures. The keen interest manifested in this problem, however, indicates gradual comprehension of the hazards. The apparent lack of action may be due to failure to appreciate the dangers of coal-mine dusts as well as lack of knowledge of the necessary steps to be taken to allay them. Discussion of these dangers and preventive measures should be an incentive to mine officials to try to use or find methods to allay mine dust and thereby reduce explosion as well as other hazards.

THE COAL-DUST HAZARD

Tests and demonstrations of the explosibility of nonanthracite coal dusts by the Bureau of Mines have shown conclusively that coal dust, except possibly anthracite dust, is explosive and that the skepticism of many persons as to the explosibility of low-volatile coals is unjustified and unfounded. Tests by the Bureau at its Experimental mine have brought out the fact that not only is low-volatile coal dust explosive but also that it is virtually as explosive as many high-volatile coals if the source of ignition is violent.

Tests on the explosibility of low-volatile coals reported by Greenwald in Report of Investigations 3489 show that not only is the explosibility greater than formerly indicated but also that the explosibility is greatly increased when the explosion is initiated by gas. Most of the low-volatile coals now being mined require more than 60 percent incombustible matter to be present to render them inert to explosion. In fact, it is these data that have caused the Bureau to advocate that all coal mines except anthracite mines apply enough rock dust to maintain an incombustible content of at least 65 percent in the mine dust.

1/ The Bureau of Mines will welcome reprinting of this paper, provided the following footnote acknowledgment is used: "Reprinted from Bureau of Mines Information Circular 7151." Presented at a meeting of the Coal Mining Institute of America, Pittsburgh, Pa., December 12-13, 1940.

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The presence of explosive gas in the mine air also increases the amount of inert matter required to render the coal dust nonexplosive. The Mine Safety Board of the Bureau recommends that the minimum incombustible content of mine dust be increased 1 percent for each 0.1 percent of methane gas in the air current. Unfortunately many mine managements refuse to concede that nongassy mines need to be rock-dusted, and at the same time decline to consider a mine gassy unless explosive gas can be detected in the air current with a flame safety lamp. The fallacy of this conception of a gassy mine has been proved by the West Virginia Department of Mines, which has found that by using a methane indicator in holes drilled into the coal in many so-called nongassy mines an explosive mixture of gas has been detected, following which fire-boss examinations have found explosive mixtures of gas in the air currents. Samples collected by the Bureau of Mines under similar conditions have contained as much as 19 percent methane in spite of the fact that the management believed its mine to be nongassy.

This condition presents an explosion hazard in hand-loading mines, but in mechanized mines where the rate of advance is rapid the danger is greatly increased. The sources of ignition also are many times greater. As a result of the changed conditions the liberation of gas is more rapid and the ignition sources are more numerous in mechanical mining, greatly increasing the probable explosibility of the dust. Added to this potential hazard is the large amount of dust found in most mechanized systems.

Dust in Conveyor Mining

Properly planned and executed conveyor mining should not increase the amount of dust in mines, but in virtually all mechanical mining the keynote seems to be speed, with resulting neglect of many safety measures. Machine cuttings frequently are not loaded out before shots are fired; or, if the cutting is done in high-sulfur or high-ash coal, the material is thrown into the gob. The fine coal spills from the conveyor pans and frequently forms piles extending from the top of the pan on the natural angle of repose of the coal. The walkway beside the pan line or belt generally is dry with dust one-half to several inches thick, and the rejected coal is piled along the rib and in the gob several feet high. Dust and fine coal frequently pile around the driving motors at the end of the cross or intermediate conveyors, owing to failure to stop these conveyors when the mother conveyor is stopped while a loaded car is being taken away and an empty car is brought under the conveyor boom. Even when the conveyors are stopped, in some instances men at the face continue to load the face conveyor until it is piled high with coal: when the conveyor is started again the overload is shaken off along the pans and at the discharge points.

Conveyor mining is generally limited to coal less than 4 feet in thickness, and in general the concentration of dust should be greater than in high coal; but during loading by hand the coal is lifted such a short distance from the floor that apparently the dust is not raised into as dense a cloud as when loading is done into cars. Even so, in most instances the concentration of dust is too great. Hand-loading onto a conveyor in coal 28 to 30 inches thick averaged 50 million particles of dust per cubic foot of air; during a test conducted while the last of a cut was being loaded out, a concentration of 140 million

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particles was found. In a mine in which the coal was 3-1/2 to 4 feet thick the average concentration of dust while loading out a cut of coal was 50 million particles per cubic foot of air. In another mine where the coal was of similar thickness the average concentration was 62 million particles, ranging from 19 to 123 million per cubic foot of air.

Dust During Loading With Mobile Units

Coal loaded by mobile units tends to produce more dust than hand loading on conveyors. The digging action of the arms tears the coal loose from the broken face, causing clouds of dust to be thrown into the air, especially where the coal is shot with heavy charges. The greatest amount of dust is raised when the last of the cut is being loaded, as the finest coal is found during this part of the cycle. Loading of machine cuttings is also an extremely dusty operation, and as this is done frequently during loading of the last of the cut the dustiness is accentuated. The dust raised at the end of the boom, where the coal discharges into the car, is denser than at the digging end of the machine.

A preliminary study of seven mines in coal averaging about 6 feet in thickness indicates dust conditions in mechanical mining where mobile loaders are used. A blank count taken before the tests were begun gave an average of 20 million particles per cubic foot of air where undercutting was practiced and 29 million where coal was top-cut. At the end of the sumping-in operation the average density with undercutting was 54 million and with top-cutting 96 million particles of dust per cubic foot of air. At the end of under-cutting the concentration averaged 63 million and top-cutting 142 million particles of dust per cubic foot, hence nearly two and one-fourth times as much dust was thrown into the air of the working place by top-cutting as by under-cutting. Shearing averaged 91 million particles of dust per cubic foot of air, and blasting 70 million particles per cubic foot of air; in connection with the air dustiness due to shearing it may be well to remember that the average shear cut is much less in area than either the average undercut or the average over-cut, and, moreover, than is likely to be a much smaller total quantity of dust thrown into the air by the shear because of the much less time consumed in making a shear cut than either an over-cut or an undercut.

Loading coal mechanically in these seven mines created air dustiness ranging in average from 41 to 119 million particles per cubic foot of air, with an average for all mines of 70 million particles. Readings in the low-average mine ranged from 22 to 52 million particles and in the high-average mine from 61 to 185 million particles per cubic foot of air. These figures are based upon tests conducted during complete cycles in one place in each mine and represent a cross section of dust in one coal field. At the end of the boom, where the coal was discharging into the car, the dust was approximately of the same magnitude as at the front end of the loading machine.

Haulage

A general observation of haulage where cars are loaded mechanically, either from conveyors or directly, emphasizes the greater dustiness of haulage roads

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traveled by the mechanically loaded cars. At conveyor-discharge points the coal is very likely to be piled too high, with no blocking of the sides of the cars, with the result that considerable coal will fall off during the passage of cars. Loading directly into the mine car causes considerable spilling of coal in the working places, and frequently the coal is piled so high on the cars tha some of it falls off during transportation to the tipple. Introduction of mechanical loaders often is followed by purchase of larger cars, but usually the same weight of rail is maintained, resulting in rough roads, which increase the amount of coal spilled along the haulage roads.

Rubber-Tired Buggies

During the last 2 or 3 years rapid progress has been made in a new method of transportation in which rubber-tired buggies actuated by storage-battery-driven motors are loaded by mobile loaders, and the coal is then transported 600 to 800 feet and dumped at an inside tipple. This constitutes probably the dustiest transportation system employed in coal mines at present. Speed apparently is the essence of economic success, and for that reason tractor-treaded top-cutting machines are used. Top-cutting machines produce more dust than under-cutting machines, and when the action of the tractor treads is added the increase in dustiness is marked; this condition is intensified further by the similar treads on the loading machines. The loading machines seldom clean up the fine dust at the working face and usually leave 1 or 2 inches of dust on the floor. The buggies generally are overloaded, especially on the end nearest the loading machine, and often there is spillage from the discharge end.

Hauling by rubber-tired buggies also presents other serious dust problems - thin coal bottom is ground into fine dust by the grinding action of the tire treads, is pushed to the side by the tires, and is then raised into the air (where the road bed is dry). If the road is wet the traveling way becomes muddy and is soon full of deep ruts and holes; this condition is most pronounced where the bottom is fireclay.

Average dust conditions in two sections of a mine were studied - in one where coal was loaded into rubber-tired buggies and in another where track-type equipment was employed. The rib-dust samples in the rubber-tired-equipment section averaged 27 percent through 200-mesh and the road dust 28 percent, while the weight of dust averaged 22 and 81 grams per square foot of surface for the rib and road dusts, respectively. On the other hand, in the section where the track-type equipment was operating the dust passing through 200-mesh was 22 and 17 percent in the rib and road dust, respectively, while the weight of dust averaged 9 and 41 grams per square foot, respectively. Analysis of these figures shows that in the section where rubber-tired equipment was used the percentage of rib dust passing 200-mesh was one and one-fourth times as great, and the weight per square foot was about two and one-half times as much as where track haulage was used; about one and two-thirds as much road dust passed 200-mesh, and the total weight was nearly twice as great. These samples were taken carefully and were representative of the respective sections. Consequently, it is apparent that mining with tractor-type cutting and loading machines and rubber-tired buggies produces more than twice as much dust as is produced with conventional-type mechanical loading equipment, and that there is a marked increase in the minus-200-mesh components.

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METHODS OF CONTROLLING DUST IN MECHANICAL MINING

Modern methods of controlling dust are in reality an application of old principles. Widespread rock-dusting is essential to prevent propagation of an explosion, but tests have been made to prove that allaying the dust at the source greatly reduces its retrogression. This statement has become virtually axiomatic.

Watering Methods

Systems of applying water to allay dust in coal mines have been in effect for many years and have been satisfactory under some conditions, but little experimenting has been done to improve these systems. Tests are now being considered to determine the best places for applying water and the best types of nozzles to employ to achieve the maximum benefit from dust-control liquids and systems, and the feasibility of using various wetting agents. Virtually the only dust-allaying equipment that has received careful attention is undercutting mining machines; others have received relatively little consideration, at least in the United States.

Mining Machines

One of the most successful methods of applying water on the cutter bar of undercutting machines has been to place a water pipe through the center of the bar, terminating at or near the end of the bar. Unqualified approval of this method cannot be given because, unless the pressure is high enough and the quantity of water is great enough, dust raised during cutting may, under some specific conditions, be greater than during dry cutting. For example, the readings of a count of atmospheric dust collected during wet-cutting in a mine in which water was applied thus gave a concentration of 13 million particles of dust per cubic foot of air; and without water the count was 8 million particles. A similar condition was found in another mine, where readings of 218 and 192 million particles of dust per cubic foot of air were obtained in wet and dry cutting, respectively.

Another arrangement of water outlets on cutter bars of mining machines consists of a series of holes placed on the outcoming-bit side, so that the dust will be wetted as it travels out of the kerf. One such arrangement provides for nine 1/8-inch holes 3 inches apart. A test made on a machine having this arrangement gave readings of 6 and 68 million particles of dust per cubic foot of air for wet and dry cutting, respectively.

Dust can be abated somewhat by directing a stream of water into the channel of the bar on the intaking bits, but the results are not always satisfactory. For instance, in a mine in which the water was directed on the intaking bits a concentration of 93 million particles per cubic foot of air was obtained with water applied on the ingoing bits; and in the same working places, cut dry, the density was 247 million particles. A reduction of about 62 percent was obtained, but the amount of dust in the air was still too high. Incidentally, in one of three tests a reading of 118 million particles was obtained when cutting wet and 350 million particles when cutting dry.

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Top-cutting is generally a dustier operation than under-cutting, as illustrated by tests in a mine where both methods were employed. Following results were obtained:

Operation	Dust per cubic foot, million particles	
	Wet method	Dry method
Undercutting	47.6	167.6
Top-cutting	374.3	594.8
Percent reduction:		
Undercutting	71	
Top-cutting	37	

While a reduction of about 71 percent resulted from wet undercutting, water applied to the cutter bar of the top-cutting machine resulted in a reduction of only 37 percent, and the density, even so, was 374 million particles per cubic foot of air. Comparable results with under-cutting in another mine gave an average of 19.4 million particles of dust per cubic foot of air with wet cutting and 134.2 million particles with dry cutting. In the same mine the average count for dry top-cutting was 567.2 million particles and for wet top-cutting 179.4 million particles of dust per cubic foot, a reduction of 72 percent with top-cutting when using water but a concentration still too high for mine safety. In these tests a 1/2-inch pipe drawn to an opening about 1/4 inch at the end was directing a stream of water onto the machine bits as they emerged from the kerf.

The data cited show that most of the systems now employed are not entirely satisfactory. When water is taken into the kerf by the moving bits the dust may be reduced greatly in under-cutting and to a limited degree in top-cutting. Many mining-machine cutter bars do not have a groove in the center in which a pipe may be placed to conduct the water to the head of the bar. Where this can be done it is probable that best results may be obtained by applying water at the head of the bar or several inches from the end. Preliminary tests indicate, however, that additional application of water is desirable. Coal dust is extremely difficult to wet, and considerable fine dust is carried out of the kerf and thrown into suspension in the air. To overcome this defect in the wetting system it is believed that a fine-spray nozzle should be placed so that a fog or mist will trap the dust as it leaves the kerf. On mining machines that are not and cannot be equipped with pipes to carry water to the head of the bar the handicap may be overcome by fixing a pipe on the front of the housing in such a manner that a stream of water will be directed into the chain guides on the intaking side and by applying a spray on the outcoming bits. Further research should be conducted on the proper arrangement of nozzles and on types of undercutting machines now in service.

One of the reasons for the greater dustiness of top-cutting is that the dust issues from the kerf at or near the top of the coal bed and has a greater distance to fall, which permits greater dispersion of the dust. Initiation of the sumping operation is also very dusty, as the bits tend to throw the dust off the face into suspension in the air. The few machines observed with a nozzle directing a stream of water toward the face do not appear to be effective. No machines have been studied in which water is directed onto the bits before they enter the kerf. It is believed that this

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arrangement or the one suggested for undercutting with the outlet near the head of the bar, in addition to application of a stream or a spray on the dust as it leaves the kerf, will more effectively wet and allay the dust in top-cutting.

Under similar conditions sharp bits produce less dust than dull bits. In fact, some tests conducted on this phase of the dust problem indicate that while the dust formed per cubic foot of air with sharp bits is only about one and one-half times as great as with dull bits, the longer time required to complete the cut with dull bits indicates that about twice as much dust is produced under similar conditions. The limited number of tests does not allow definite conclusions to be drawn, and further tests should be conducted to obtain definite results.

Drilling

In hand-drilling of coal an average of a large number of tests indicates that about 35 million particles of dust per cubic foot of air is representative of this operation, although individual tests may show two or three times this concentration. In one mine representative samples averaged about twice this number for hand-drilling of coal. Electric drilling of coal (based upon tests in about a dozen mines) will produce about 105 million particles of dust per cubic foot of air. Although the dust counts cited are relatively high, the time of drilling ranges from about 5 minutes for hand drilling to about 1 minute for electric drilling, and therefore the amount of dust thrown into the air is not relatively great. Virtually all of the dust could be kept out of the air if a stream of water were directed into the collar of the hole during drilling.

Pneumatic-hammer drilling of rock, which is becoming increasingly important in mechanical mining, presents a real dust hazard. Only a few tests have been made with drilling of this type, but the results are arresting. In one mine drilling in shale raised an average of 866 million particles per cubic foot of air, and in another mine 1,135 million particles. In the same mine, where the bottom rock was drilled with electric drills the density was only 4.4 million. The answer to this problem is to use wet drilling or, where possible, to use electric drills.

Conveyor Loading

Hand-loading onto conveyors is generally done dry. The only operation studied in which water was used was one in which water was applied at the end of the cutter bar of the undercutting machine, but the coal was loaded dry. The coal was 2 feet 10 inches thick and after blasting was loaded onto a shaker conveyor. The wet-cut coal gave an average air-borne dust density of 18 million particles during loading and 50 million particles per cubic foot of air when cutting was done dry. In each test the concentration of dust in air was less than 16 million particles during loading of most of the cut, but when the back of the cut was reached and the fine coal left by blasting combined with machine cuttings not properly scraped from the cut was loaded onto the conveyor, the counts increased to 26 and 47 million where cutting was done wet and 77 and 140 million particles per cubic foot of air where the dry method was employed. These figures and personal observations indicate that there is considerable advantage in

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cutting wet; for, although in some of the tests the wetting was not considered satisfactory, from the point of view of allaying dust during cutting the dust frequently was greatly reduced during loading.

One of the greatest dust hazards in mechanical loading lies in the fact that in some systems of loading by hand onto conveyors or loading by mobile loaders onto cars, large piles of fine coal are left in rooms, either from spillage or thrown back because of high sulfur or high ash in some of the coal or in the machine cuttings. The recommended method for overcoming this condition is to load out the dust and fine coal. It has been stated that it is not economically possible to load out this coal; and while it is believed that no system should be adopted that jeopardizes the lives of employees, it is recognized that all mine operators will not accept this viewpoint. The hazard of leaving dust in the mine may be minimized if the piles left in working places are thoroughly wet, preferably with wetting agents (method to be discussed later), at the end of each shift, and a thick coating of rock dust is spread over the piles, also at the end of each shift.

The coal pile should be kept wet during loading onto the conveyors, and near the end of each shift dust and loose coal that have accumulated along the belt or pans should be cleaned up and the area rock-dusted. The walkway beside the conveyors should be kept rock-dusted or sprinkled, whichever method is best-suited to local conditions. Sprays should be installed at the discharge boom, and the coal should be wetted as it is loaded into the mine cars. As an additional precaution the area around the loading head should be kept rock-dusted. A spray should be placed on the gathering side track, and the top of the loaded cars should be wetted before the trip leaves for the surface or dumping point.

Mobile Loaders

Dust on mobile loaders is thrown into the air at the loading head and at the loading boom. Generally it is not possible to place nozzles on the loading boom, as the top of the boom frequently strikes the roof and cross bars and the underside of the boom scrapes along the top of the cars. The end of the boom also is often buried in the coal as the car is loaded. It is possible to place nozzles at strategic points on the loading head of most mobile loaders. To date no loading machine equipped with nozzles for applying water during loading of coal has been observed in operation. Some tests have been made, however, in which the coal pile was sprinkled before and during mechanical loading. In one mine the dust in an entry at a point where one cut had been taken in a room neck was collected from the air and found to have a concentration of 276 million when coal was loaded dry and 40 million particles per cubic foot of air when loaded when the coal was sprinkled. Tests in another mine gave averages of 139 and 44 million particles per cubic foot of air in dry and wet loading, respectively, the coal pile being sprinkled before loading begins and during loading if the coal gives off appreciable dust. These tests were so limited in scope that they are not indicative of mechanical loading where water is used. Nevertheless, the results so closely approximate tests made with hand loading under similar wetting conditions that the results possibly approximate average conditions when coal is loaded mechanically.

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Sprinkling the coal by means of a hose during loading is not feasible in many mines where the block system of mining is followed, as the rooms and entries are generally so narrow that it is not safe for a man to stand beside the mobile loader. Further research is planned on the proper placing of nozzles on loading machines, but suggested methods of wetting the coal pile during loading are:

1. Thoroughly wet the pile shortly before loading.

2. Place a spray nozzle on each side of the conveyor near the top of the machine so that sprays will be directed on the coal as it is loaded into the loading head.

3. Where this method is not feasible or, in addition to (2), where crossbars are employed to support roof at the face, a pipe equipped with several spray nozzles could be attached to the front of the first crossbar and a hose attached to this pipe so that water or other liquid could be sprayed on the coal as it is loaded. Where steel H-beams are used, suitable, readily adjustable clamps could be provided for quickly attaching the pipe to the bar. Suitable clamps for quickly fastening such a pipe to wooden bars may also be provided at little cost. If the application of water at the loading head is adequate there should be little if any need for additional wetting at the discharge boom.

Rubber-Tired Buggies

Deep concern is felt by saftey men over the increased hazard presented by dust conditions in sections where rubber-tired cars or buggies are used. These conditions have already been discussed. The answer to the problem is still a subject of research, but preliminary studies indicate that the following steps should be taken:

1. Machine cuttings should be loaded out before the coal is shot.

2. Loose coal and dust left by the mobile loader should be loaded out before the coal is cut again.

3. Coal left on the bottom should be loaded out, as this coal will be ground fine and create an additional hazard.

4. Coal spilled from the buggies should be loaded out at the end of each shift.

5. Buggies should not be loaded so full that coal will spill during tramming.

6. Gates should be provided on the discharge end of the buggies to prevent spilling during tramming.

7. Sprays should be provided at the bottom and top of the inside tipples, the number (possibly three or four) to be determined by trial.

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8. Each place should be rock-dusted after each cut of coal has been loaded out, and the haulage routes should be redusted as often as necessary, determined by periodic sampling.

9. Where the bottom material will permit, the road should be sprinkled at least once a day or as often as necessary to keep the dust from being raised into a cloud by the buggies. The use of wetting or reducting agents may be found to be beneficial in settling the road-bed dust.

Haulage

The repeated recommendations of the Bureau of Mines for use of water should be followed. These methods are not new, are well-known to most mining men, and are repeated for emphasis.

1. Water sprays should be provided at each gathering sidetrack, and the tops of all cars should be wetted thoroughly before loaded trips leave for the shaft bottom or the outside.

2. Coal should be wetted as the cars are dumped.

3. The empty cars should be wetted before they are taken underground to prevent dry dust from being taken back into the mine.

4. Haulage roads may also be wetted whenever necessary to reduce the amount of dust raised during passage of trips, provided that the haulage entries are adequately rock-dusted on ribs, roof, and timbers.

WETTING AGENTS

Interest in allaying dust has been overcome by the fear on the part of some mine officials that the added water would be detrimental to the sale of coal, and no steps have been taken to install dust-allaying systems. This objection has been met by the proposal to use wetting agents. A number of patented products have been offered to the mining industry, but no conclusive results have been reported. The Bureau of Mines is keenly interested in this phase of the dust-control problem, and preliminary tests have been made; more exhaustive tests are planned, and it is hoped that use of wetting agents will prove to be the answer to those who do not wish to employ water alone.

Wetting agents have been used for many years, principally in the textile industry and in metallurgical and milling processes. Two types of mixtures are employed - one in which the ingredient forms an emulsion and the other in which the agent mixes intimately with water. In selecting wetting agents care should be taken to use the one best-suited to mine conditions. Some materials that will perform adequately on textiles will not react satisfactorily with coal or the impurities in coal. Others require a temperature higher than is usually found underground. Still others must be agitated constantly or frequently to keep them in solution. Certain materials are oily or sticky and adhere to the moving parts and conveyors of loading machines. Odor may be too objectionable for underground use of other ingredients. Certain types of containers may be

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necessary, as the wetting quality of some wetting agents may be destroyed by the constituents of the container.

Several years ago some tests were made underground with a wetting agent, and during undercutting it was found that water allayed dust about as satisfactorily as did the wetting agent. It is believed that the container had constituents that destroyed the wetting properties. Since then a few tests have been made that were too limited in scope to permit making deductions as to the merits of wetting agents, but certain possibilities were shown.

One of the claims made is that wetting agents will greatly reduce the quantity of water required to allay dust. This claim was substantiated by some tests. Certain agents probably will require only a half or a third as much liquid as water alone. Dust at a discharge point in a tipple during a test was reduced about 70 percent, and the amount of water used was reduced about 70 percent by applying a wetting agent in water, thus indicating that the amount of water necessary can be reduced.

The amount of water used during top-cutting also may be reduced through application of wetting agents. Several studies proved that more than 50 percent reduction in dust density is possible with wetting agents as compared to water, or that less than half as much liquid need be used. These were preliminary results obtained while trying different arrangements of nozzles. It is believed that a different arrangement as well as a different type of nozzle may effect an even greater reduction in amount of liquid necessary and a notable decrease in dustiness. Even the dust that landed on the impinger during the tests was damp and presumably would have settled to the floor rather than remain suspended in the air.

Another characteristic of wetting agents is their dispersion through a pile of coal dust. If enough liquid is applied to the top of a pile, apparently it will work its way to the bottom, but it will also coat the surfaces of the various particles and will tend to remain there for a longer period than will water. Once dust has been wetted, it may be thoroughly wetted again by application of water alone. These two properties may be useful in treating piles of gobbed dust such as in conveyor rooms. If the top of the pile is wetted with the proper agent the entire pile may become wet, and if the rock dust is applied in a thick coat evaporation probably will be retarded to such an extent that the dust will be kept damp. Tests at the Bureau's Experimental mine with only one wetting agent showed that that particular wetting agent did not prevent propagation of an explosion, but no tests were made with rock dust on top of the wetted dust. Further tests should be made to determine the effect of this combination of wetting agent and rock dust.

SUMMARY

The problem of controlling dust in mechanical mining requires further research to determine the best places for jets and nozzles and the proper placing and types of nozzles. Water should be applied near the head of cutter bars on mining machines or on the ingoing cutting chain and bits, supplemented with spray nozzles so placed that they will trap dust escaping from the kerf.

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Directing a stream of water into the collar of the hole during drilling of coal probably will eliminate most of the dust, but drilling rock with pneumatic hammer drills should be done wet, water being forced through the hollow center of the drills.

Coal piles should be wetted thoroughly after blasting and, if feasible, during loading with mobile loaders. Spray nozzles should be installed on the loading head near the top of the conveyor guide, supplemented by sprays placed on the front of a crossbar at the coal face. Where rubber-tired buggies are used the loose coal and dust should be cleaned up after each cut of coal has been loaded out, coal bottom should be removed, loose coal spilled along the road traveled by the buggies should be cleaned up at the end of each shift, and buggies should not be overloaded. Gates should be placed on the discharge end of the buggies to reduce spillage of fine coal. Spray nozzles should be placed at each end of the conveyor on inside tipples.

The objection to the use of excessive quantities of water may be overcome by employing wetting agents. However, care must be exercised to obtain agents suitable for the work to be done. Wetting agents give promise of reducing the quantity of water necessary as well as of removing more dust from the air than can be done with water alone.

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